



# Results of radiation tests with HL-LHC detection electronics and quench heater power supplies

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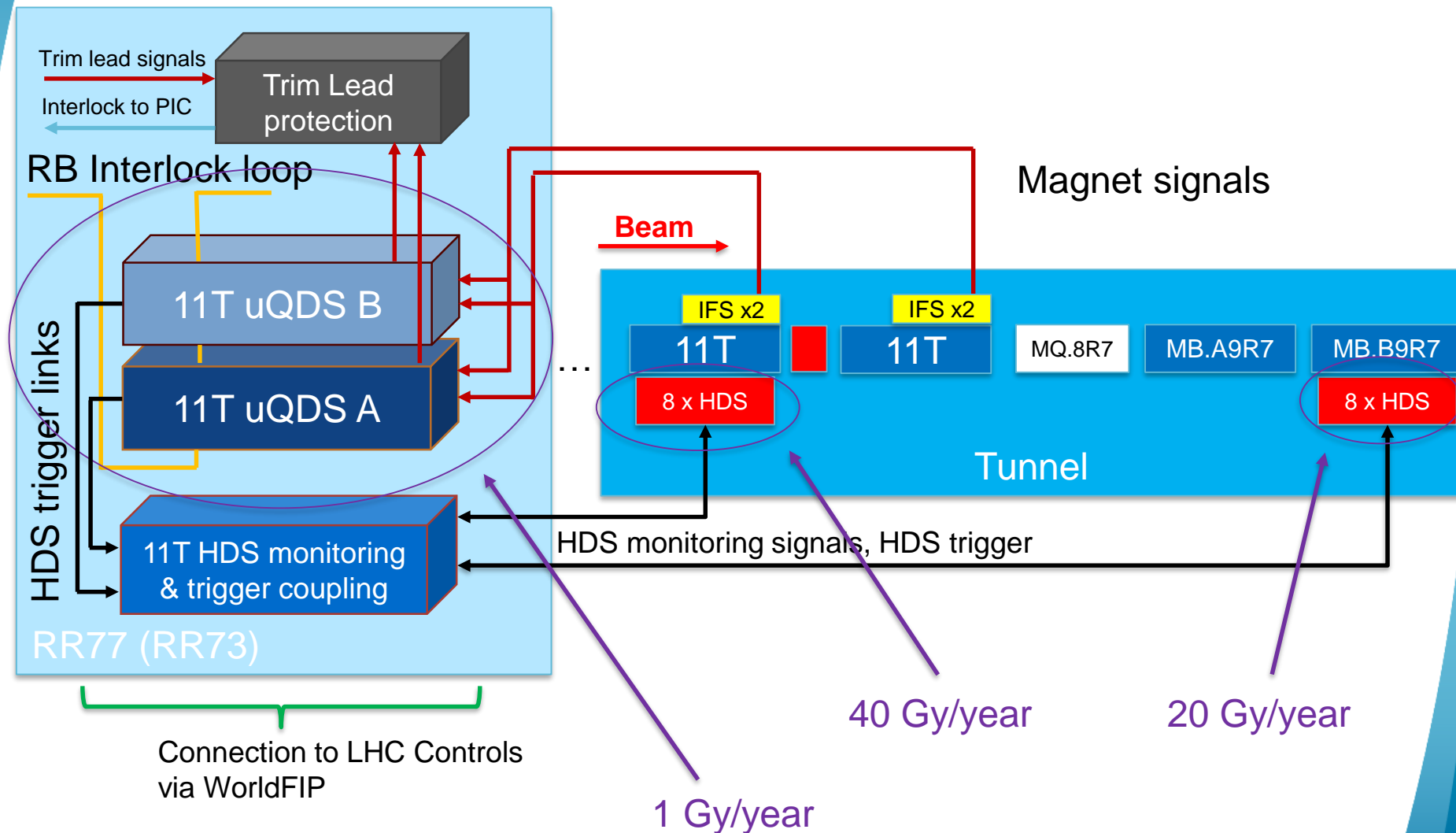


8<sup>th</sup> HiLumi Collaboration Meeting, CERN, 15-18 Oct. 2018

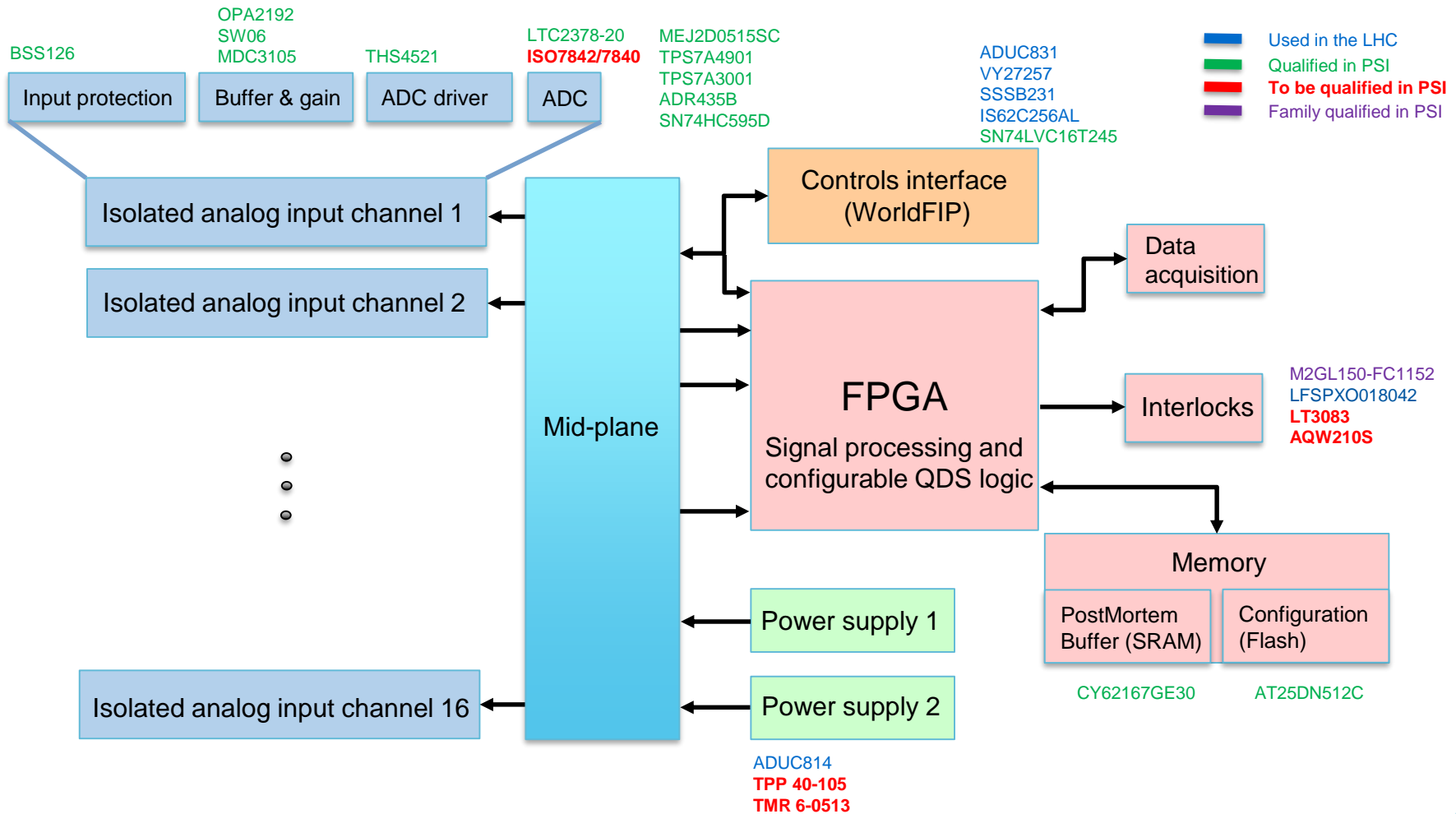
# Outline

- 11T HL-LHC quench detection – overview
- Universal Quench Detection System (uQDS) overview
- Testing of uQDS in CHARM
  - Test setup
  - Test results
- Quench Heater Discharge Supply (DQHDS) overview
- Testing of DQHDS in CHARM
  - Test setup
  - Test results
- Ongoing activities
- Conclusions

# 11T HL-LHC Quench Detection System (uQDS)

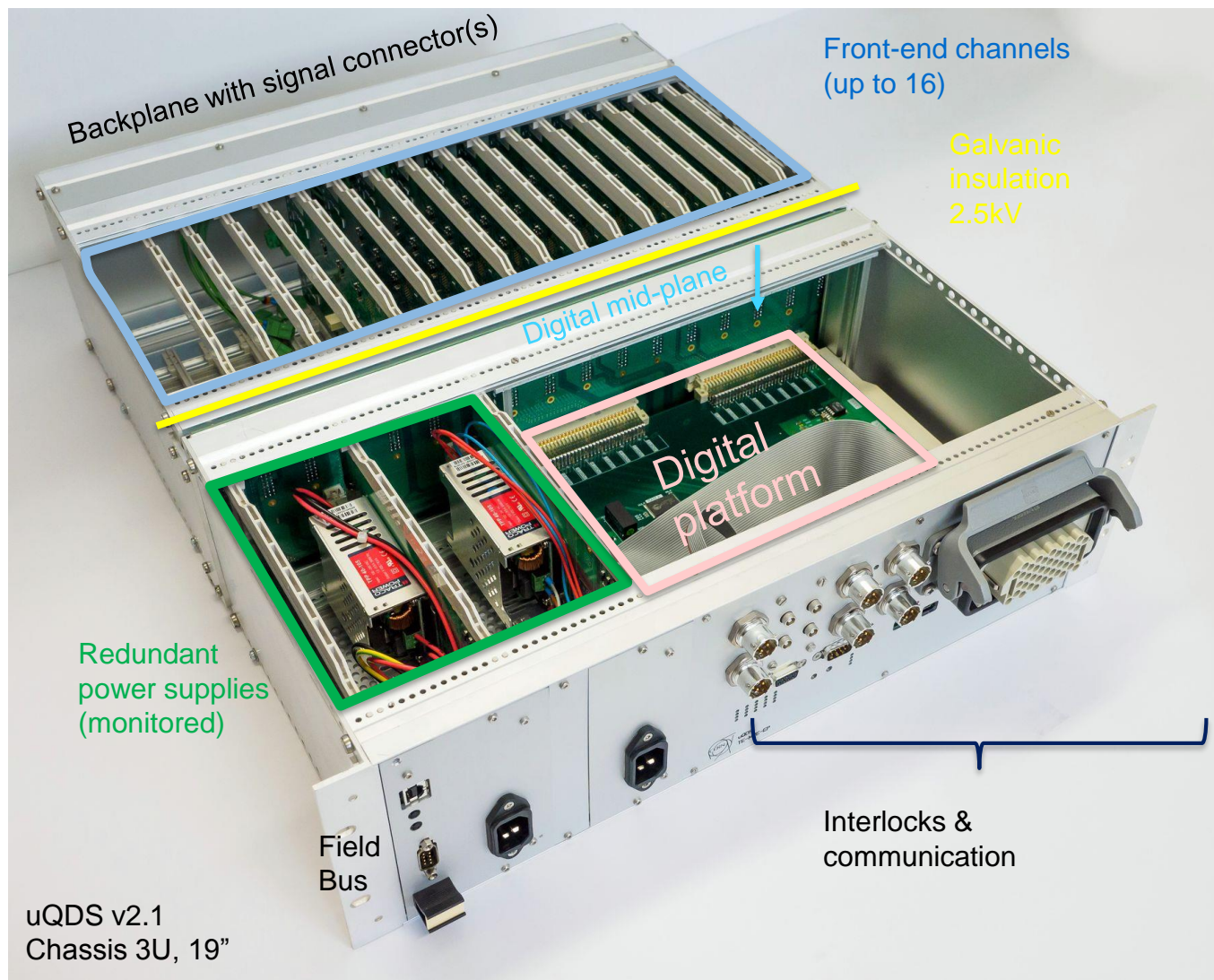


# uQDS – System Overview



Details given in [the talk of Jens](#)

# uQDS v2.1

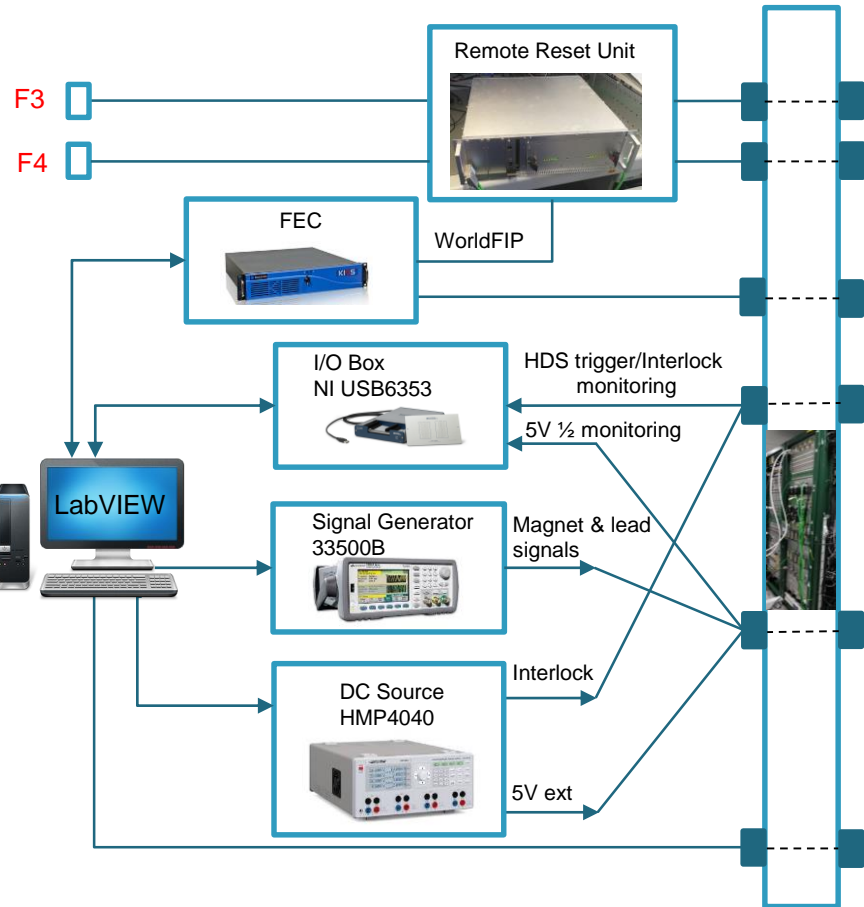


# uQDS Test Setup – CHARM

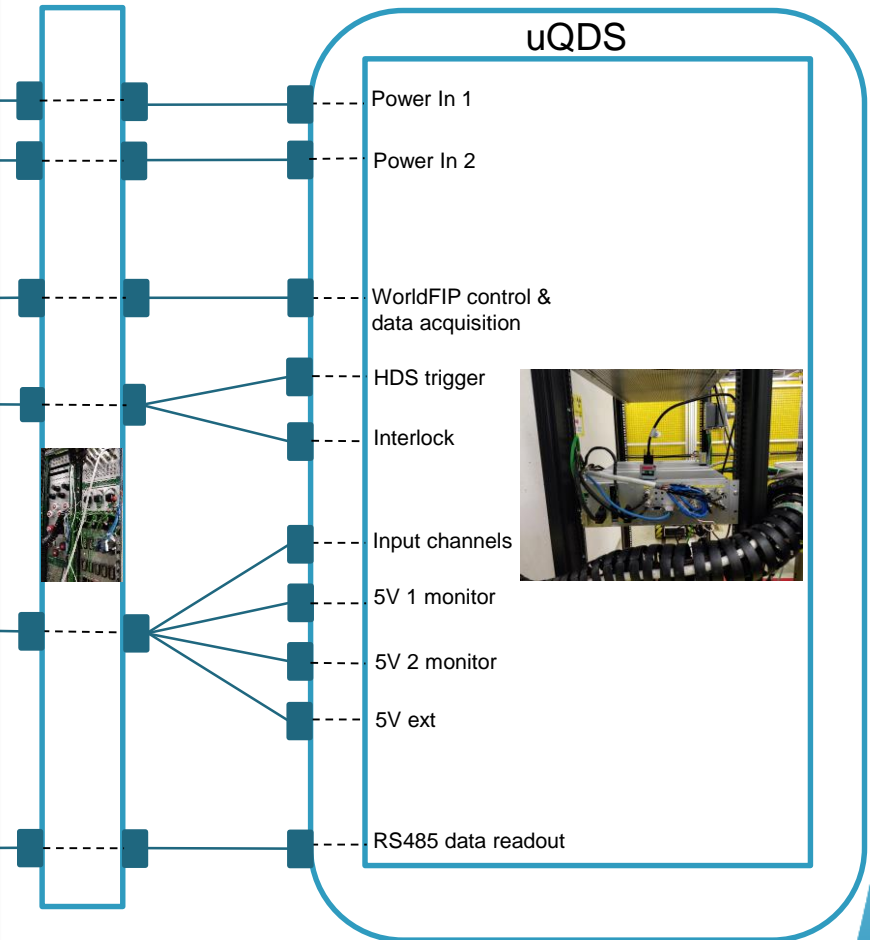
- Test performed from 26.09.2018 to 03.10.2018
- Test performed at position 10 ~ 50 Gy/day
- uQDS unit equipped with 4 analog input channels
  - 2 (“magnet”) channels 20 Vpp, 0.1 Hz sine wave, bridge configuration
  - 2 (“lead”) channels 40 mVpp, 0.1 Hz sine wave
- Configuration and signal acquisition via
  - WorldFIP – 10 Hz, “slow” acquisition
  - RS485 – 1 kHz, “fast” acquisition
  - NI I/O box – 1 kHz
- Test stimuli remotely controlled – signal offsets, to check quench detection, interlock loop opening and heater discharge activation
- Remote “healing” via reset and power cycle

# uQDS Test Setup – CHARM

## CHARM control room



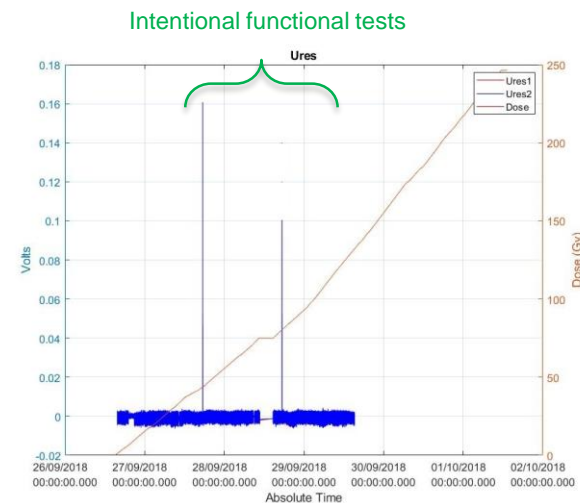
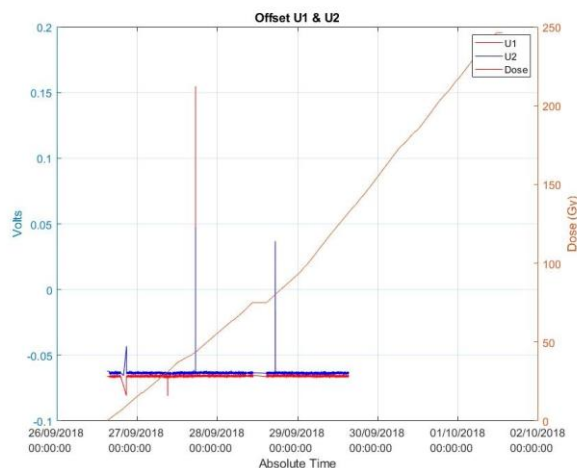
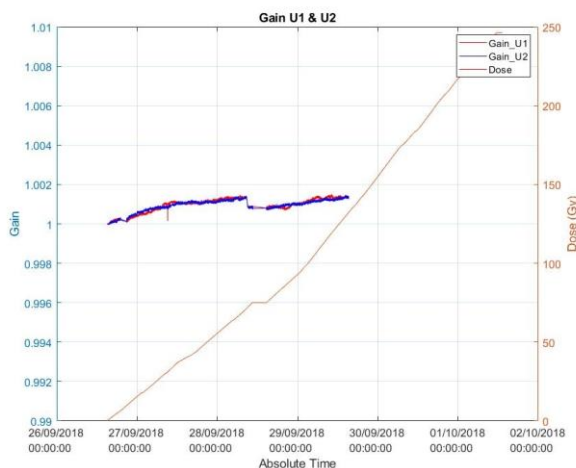
## CHARM test room





# uQDS Test Results – CHARM 1/4

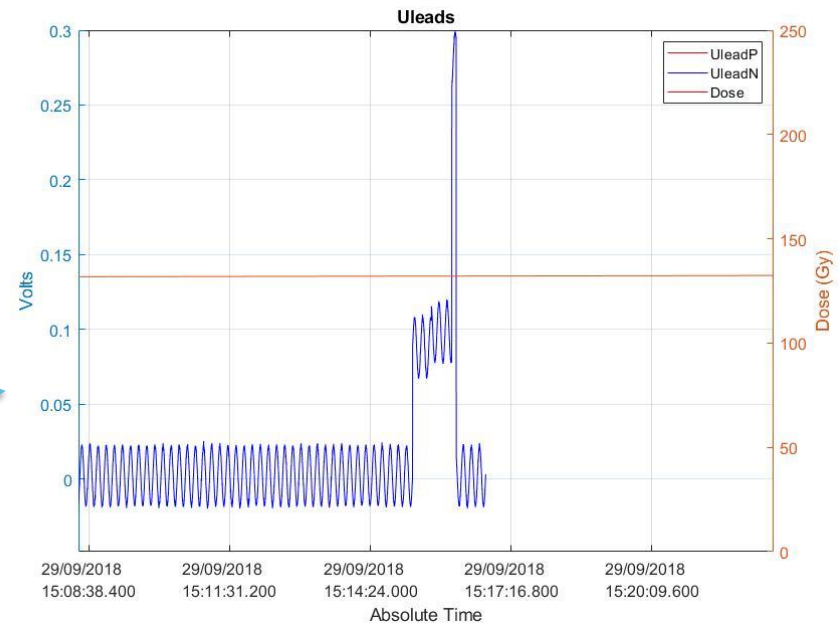
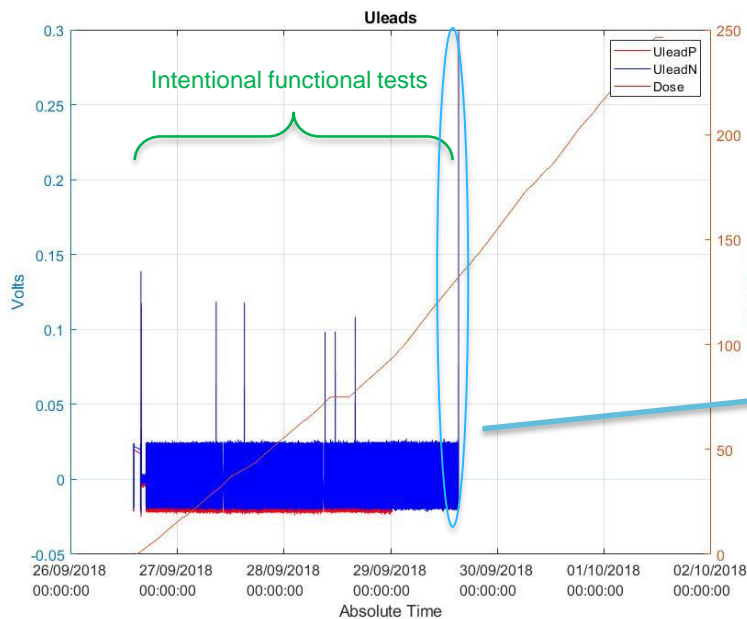
- WorldFIP interface card stopped working at 60 Gy
  - No slow logging beyond 60 Gy
- Analog channels worked well (at least) up to 130 Gy
  - Fast logging data available up to 130 Gy
  - 0.15% variation in channel gain for “magnet” channels (bridge configuration)
  - Variation in offset negligible with dose





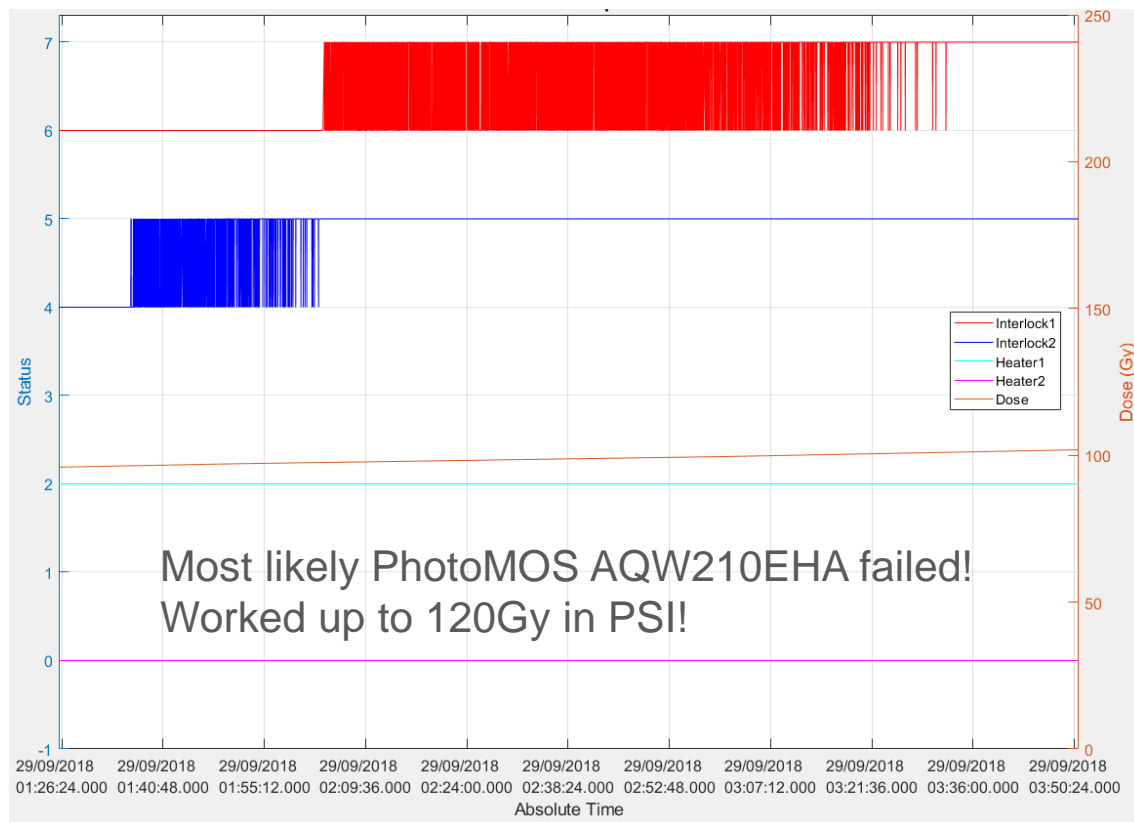
# uQDS Test Results – CHARM 2/4

- WorldFIP interface card stopped working at 60 Gy
  - No slow logging beyond 60 Gy
- Analog channels worked well (at least) up to 130 Gy
  - Fast logging data available up to 130 Gy
  - Signal variation negligible with dose



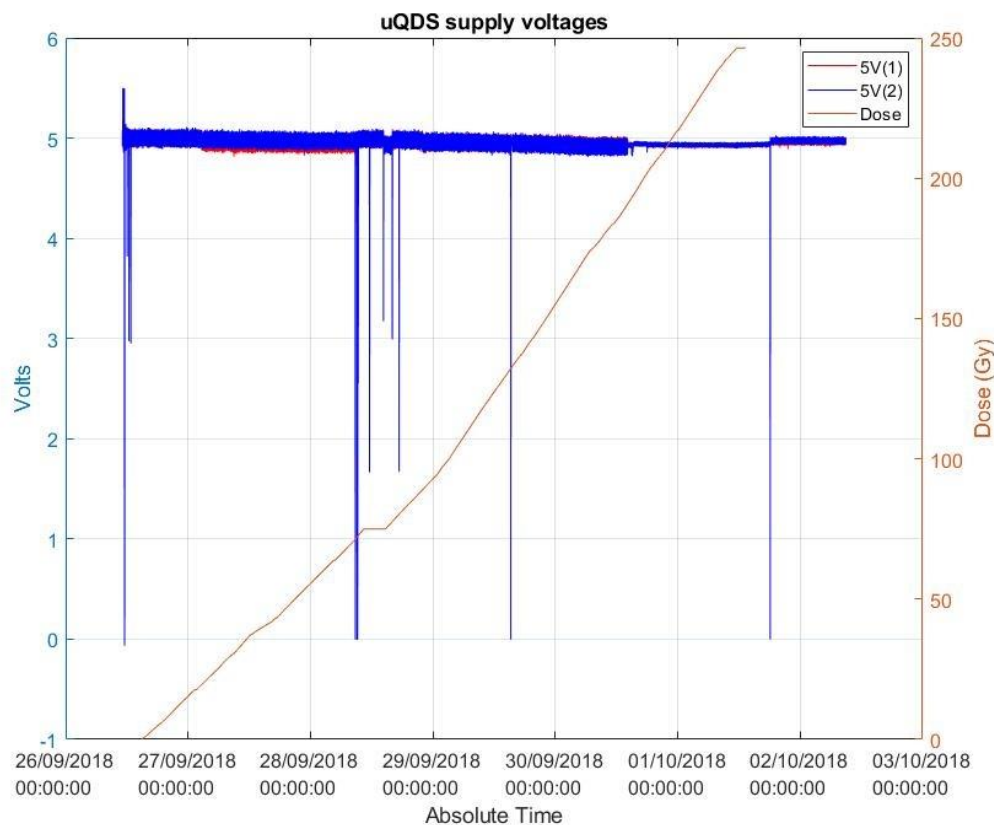
# uQDS Test Results – CHARM 3/4

- Digital platform worked well up to 100 Gy
  - At 100 Gy Interlock loop could not be closed
  - At 130 Gy data acquisition stopped



# uQDS Test Results – CHARM 4/4

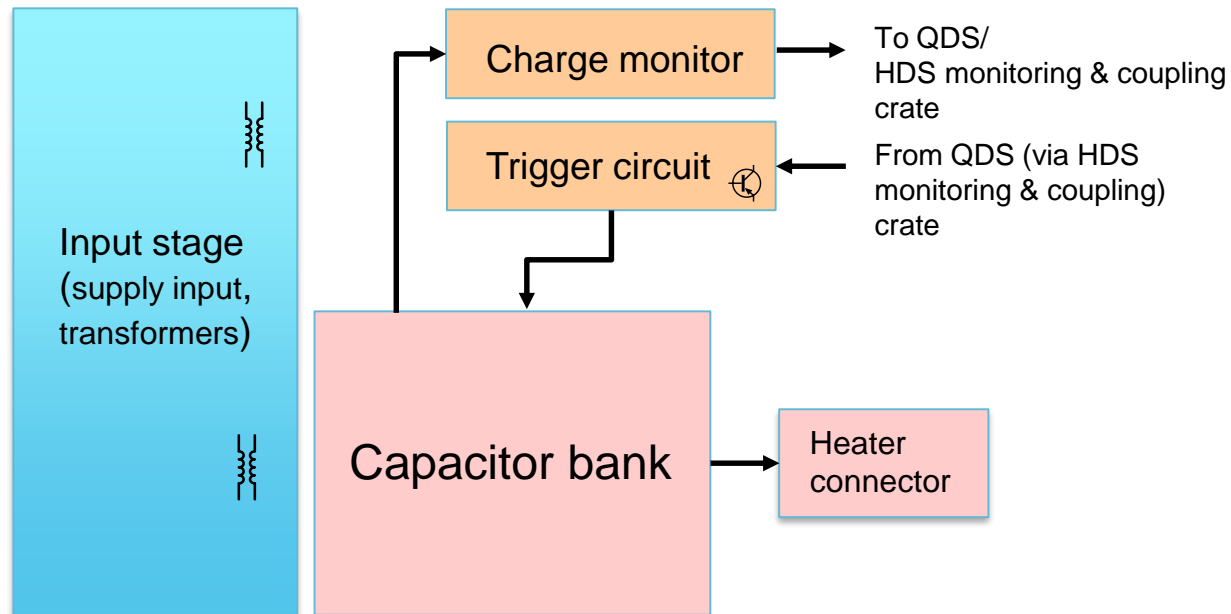
- Power supplies survived 250 Gy!
- Pulses correspond to power cycle commands



# DQHDS System Overview

■ Qualified in PSI  
■ To be qualified in PSI

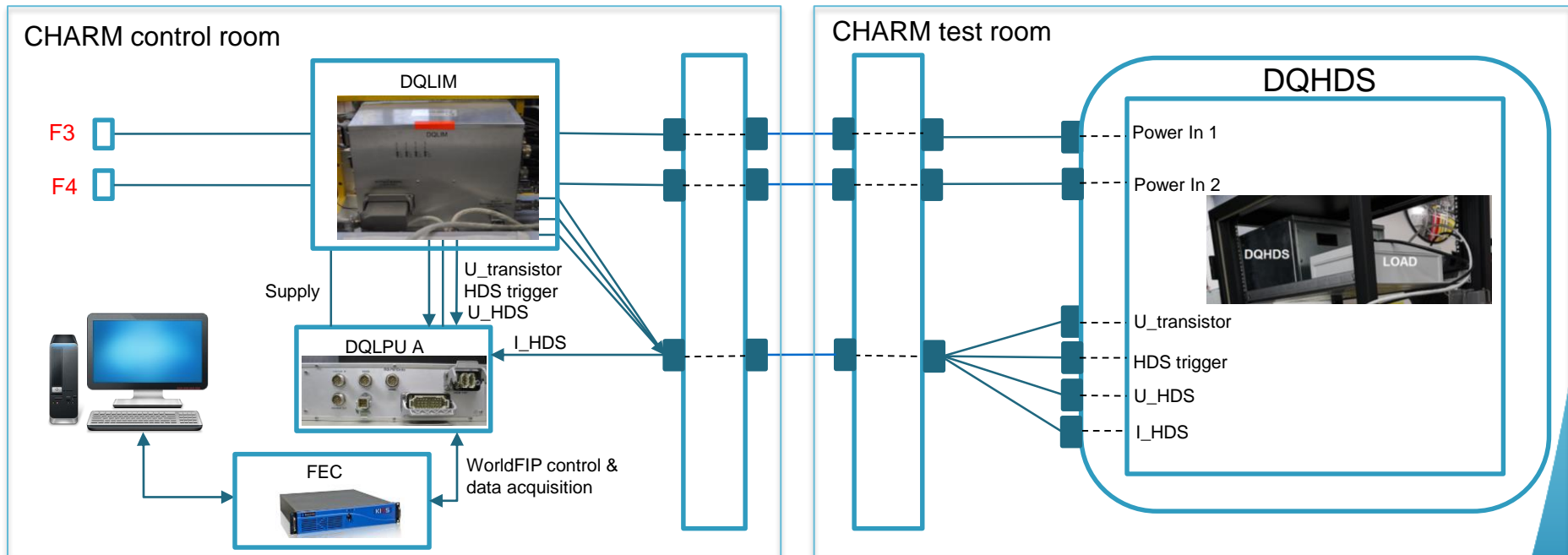
ZTX653  
L7815  
SKT 80/18E



Details given in [the talk of David](#)

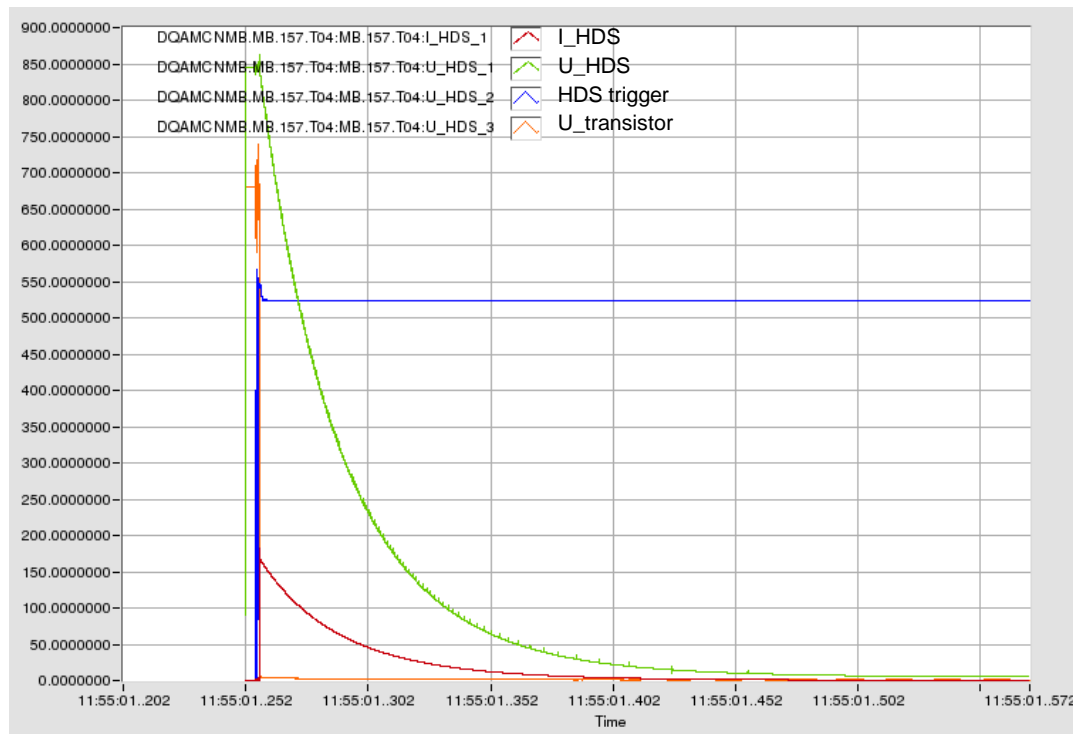
# DQHDS Test Setup – CHARM

- Test performed from 03.10.2018 to 17.10.2018
- Test performed at position 13 – 100 Gy/day
- DQHDS discharge automatically triggered every hour
- Signal acquisition via DQLPU type A



# DQHDS Test Results – CHARM

- Stopped functioning after 420/470 Gy
  - Capacitor bank could not be charged – fault detectable during the (LHC) operation
  - More detailed analysis pending



# Ongoing Activities

- Preparation of a field-bus coupler which uses the NanoFIP IP core (BE-CO) for the beginning of Run 3
  - To be tested in radiation
- Preparation of a 3-channel board for the beginning of Run 3 to improve detection and radiation tolerance
  - Readout board for di/dt sensor used for detection of symmetric quenches in Individually powered quadrupoles and 600A correctors
  - Replacement for the existing detection boards for 600A correctors
  - Replacement for the existing detection boards for Inner Triplets
- Radiation qualification of used components



# Conclusions

- uQDS was successfully tested in CHARM
  - More detailed analysis of the irradiated unit pending
- DQHDS was successfully tested in CHARM
  - More detailed analysis of the irradiated units pending
- Activities ongoing to further improve radiation tolerance of the detection systems in the scope of the HL-LHC upgrade



***Thank you for your attention!***

